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(54) ADJUSTABLE CRASH DISCRIMINATION SYSTEM WITH OCCUPANT POSITION DETECTION

ADAPTIVES SYSTEM ZUM ERKENNEN VON ZUSAMMENSTÖSSEN MIT ERFASSUNG DER INSASSENPOSITION

SYSTEME REGLABLE DE REPERAGE D'ACCIDENT PERMETTANT LA DETECTION DE LA POSITION DE L'OCCUPANT

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(56) References cited:

WO-A-93/21043	WO-A-94/22693
DE-A- 3 802 159	DE-A- 4 023 109
US-A- 4 620 721	US-A- 4 625 329
US-A- 4 985 835	US-A- 5 118 134
US-A- 5 256 904	US-A- 5 291 014

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to motor vehicle crash discrimination systems utilized for actuating or deploying a passenger safety restraint, and more specifically to apparatus and method for improving reliability of a motor vehicle crash discrimination system.

[0002] Conventional vehicle crash discrimination systems typically employ at least one mechanical, electromechanical, or electronic acceleration sensor affixed to the vehicle for sensing vehicle acceleration. The output of the sensor(s) are supplied to a discrimination circuit for comparison to a predetermined threshold value. If the predetermined threshold value is exceeded, the discrimination circuit will output a signal which actuates or deploys a passenger safety restraint, such as an airbag or passive seat belt mechanism.

[0003] However, conventional mechanical or electromechanical accelerometer based crash discrimination systems do not account for variations in passenger/occupant conditions in determining whether to actuate the safety restraint. More specifically, conventional accelerometer based crash discrimination systems are generally designed to assume nominal conditions, such as 50th percentile male, actual presence of a vehicle occupant, and failure of an occupant to wear a seat belt. The assumption of these crash conditions are necessary to insure proper actuation of the safety restraint when severe deceleration of the vehicle is detected by the accelerometer. Such assumptions inherently cause unnecessary, undesired, or improperly-timed actuation of the safety restraint in conditions where no occupant is present, in marginal crash situations where a seat belt provides sufficient safety protection for the occupant, or in situations where the occupant is improperly positioned relative to the safety restraint such that actuation of the safety restraint could potentially injure the occupant.

[0004] Further, each type of vehicle structurally reacts in a unique manner when experiencing identical crash situations. Since conventional accelerometer based crash discrimination systems detect crash situations based on deceleration of the vehicle, the accelerometer must be specifically calibrated for the particular type of vehicle to which it will be mounted. The requirements of unique calibration adds to the cost and complexity of conventional accelerometer based crash discrimination systems.

[0005] Another known vehicle crash discrimination system disclosed in U.S. Patent 5,118,134 to Mattes et al measures both the forward displacement and/or velocity of vehicle occupant, and the acceleration of the vehicle in determining when to actuate a safety restraint. The forward displacement or velocity of the occupant is measured using ultrasonic, light or microwave signals. The vehicle acceleration is compared to a first threshold value, the forward displacement of the occupant is compared to a second threshold value, and the velocity of the occupant is compared to a third threshold value. The safety restraint is actuated when the first threshold value is exceeded, and either the second or third threshold values are exceeded.

[0006] While the system disclosed in U.S. Patent 5,118,134 improves reliability over conventional accelerometer based crash discrimination system by measuring occupant displacement or velocity, the system is still relatively rigid because of the use of preset threshold values as the decisional criteria for actuating the safety restraint. This arrangement does not allow the crash discrimination system to accommodate various occupant conditions which can affect the desirability of actuating the safety restraint.

[0007] DE 40 23109 discloses a method and system for actuating vehicle occupant safety restraints based on a comparison between the measured occupant position and sample values stored in a memory. This system allows the time of triggering of the safety restraints to be varied according to the situation. The precharacterising sections of claims 1 and 10 are based on DE 4023109.

[0008] According to the present invention there is a method for optimizing a discrimination analysis used in a system for actuating a vehicle occupant safety restraint in response to a vehicle collision comprising the steps of:

> continuously detecting a static position of a vehicle occupant relative to a fixed structure within the vehicle; and
> adjusting a discrimination threshold value used in the discrimination analysis for determining whether actuation of the safety restraint is required based on the detected static occupant position;

characterized in that said method further comprises the step of differentiating irrelevant occupant movements from movement caused by a crash situation based solely on the variation of said detected static occupant position with time and said discrimination threshold is also adjusted based on the result of said differentiating step.

[0009] According to the present invention there is a system for actuating a vehicle occupant safety restraint in response to a vehicle collision comprising:

> means for continuously detecting a static position of a vehicle occupant relative to a fixed structure within the vehicle; and
> processor means comprising:
>
> > a means for discriminating a vehicle crash requiring actuation of the occupant safety restraint, said discrimination means having a predetermined discrimination threshold value for

use in the discrimination analysis; and a means responsive to the data representative of the detected static occupant position for adjusting the discrimination threshold value;

said system characterised in that said processor means further comprises a means for differentiating irrelevant occupant movement from movement caused by a crash situation and said means for differentiating differentiates according to solely the variation of said detected static position with time.

[0010] The present invention can provide a method and system for vehicle crash discrimination having increased efficiency and reliability in actuating or deploying a safety restraint such as an air bag.

[0011] Also the method and system can continuously detect various vehicle occupant positions for optimizing a discrimination analysis to achieve increased efficiency and reliability in actuating a safety restraint.

[0012] The decision period used for determining when to actuate a safety restraint can be adjusted, wherein the adjustments may be based on the distance between a vehicle occupant and a potential impact point within the vehicle, and the change in distance over a period of time.

[0013] The distance between a vehicle occupant and a potential impact point within the vehicle can be determined, and this information can be utilized for adjusting a discrimination analysis threshold value, and as criteria for determining whether to actuate an occupant safety restraint.

[0014] The method and system for discriminating vehicle crashes can utilize an optical low threshold acceleration sensor to calibrate an optical occupant position sensing means and to generate an output signal representative of vehicle acceleration.

[0015] The method and system can measure and record data concerning the changes in occupant position caused by actual crash situations.

[0016] The present invention will be more fully understood upon reading the following detailed description of the preferred embodiment in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a schematic illustration of motor vehicle crash discrimination system having an occupant position detector in accordance with the present invention;

Fig. 2 is a schematic illustration of a first embodiment for detecting the occupant position;

Figs. 3 (a)-(c) are a schematic illustration of a second embodiment for detecting the occupant position;

Figs. 4 (a)-(c) are a schematic illustration of a third embodiment for detecting the occupant position;

Fig. 5 is a schematic illustration of a fourth embodiment for detecting the occupant position based on the embodiments shown in Figs. 3 (a)-(c) and Figs. 4 (a)-(c);

Figs. 6 (a) and (b) respectively illustrate a plot of position data relative to a fixed structure within the vehicle over time for irrelevant occupant movement, and occupant movement responsive to a vehicle crash; and

Fig. 7 is a schematic illustration of a further embodiment of the vehicle crash discrimination system having an optical low threshold safing sensor.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0018] Referring to Fig. 1, there is shown a vehicle crash basic occupant condition discrimination system 10 which senses various occupant conditions in accordance with the present invention. The system 10 comprises an active infrared position detector 12 comprising a modulator 14 connected to an optical transmitter 16, and an optical receiver 18 connected to a synchronous demodulator 20. The demodulator 20 generates an output 22 indicative of the position of an occupant 24 relative to a potential impact point within the vehicle. Output 22 is supplied to a signal processor/discrimination unit 26 for storage in a memory 36, and subsequent use as decisional criteria in a vehicle crash discrimination analysis, adjusting discrimination parameters, and/or data recording, as will be more fully described hereinbelow. In response to analysis of the input information, processor/discrimination unit 26 controls actuation, or deployment, of one or more passenger safety restraints, such as an airbag 38, via at least one output line 28, or the activation of an audible or visual warning device(s) 40 via at least one output line 30 for alerting the vehicle occupant 24 to a potentially hazardous seating condition. The infrared position detector 12 and the signal processor 26 receive power from a vehicle battery 32.

[0019] The system 10 is mounted on and/or in the vehicle steering column or dashboard. In a crash, the system 10 will experience essentially the same decelerations as a conventional electromechanical acceleration sensor, i.e., "accelerometer." However, the occupants are not rigidly affixed to any cabin structure, and therefore, an occupant's motion, or reaction to a crash will be somewhat different from a conventional accelerometer. The system 10 will measure the relative distance and motion of the occupants relative to the fixed structure within the vehicle. As will be described more fully hereinbelow, advanced signal processing techniques performed in the processor/discrimination unit 26 will allow identification of those situations where deployment of a safety restraint is required. The system 10 is further able to recognize or identify occupant motion characteristic

of seat belt usage, and to distinguish this type of motion from occupant motion where no seat belt is being used. Occupant motion recognition or identification through advanced signal processing techniques also enables the system 10 of the present invention to distinguish irrelevant, or spurious occupant motions such as a hand or arm moving through the incident beam.

[0020] In operation, a narrow infrared beam 34 is directed horizontally at the expected position of the driver or passenger. At least a portion of the light energy scattered by the occupant's clothing is detected by receiver 18, which is located away from the beam axis so that the receiver 18 can detect differences in reflected light intensity and angle associated with occupant absence, presence and forward motion. The infrared beam 34 is distinguished from ambient light of the same wavelength by modulating the signal 34. A modulation frequency of about 10 KHz or higher provides acceptable modulation since a minimum of 10 KHz is well within the range of most existing electronic and optical systems, and is fast enough to monitor passenger movement in real time. Determination of the instantaneous distance of the occupant from the transmitter 16 is based on the relative intensity of the light scattered by the occupant as detected by a detector or detectors, with measurements based on relative intensity or the angle from which the light is received.

[0021] Referring to Fig. 2, there is shown a first embodiment 100 for determining the position of an occupant based on the principle that light intensity is proportional to $1/r^2$, where r = distance of scattering surface from the receiver 18. In the $1/r^2$ embodiment 100, the receiver 18 comprises a pair of photodiode detectors 102 and 104 situated a known distance apart, and placed at different distances from the point where the incident light is reflectively scattered. The receiver 18 is preferably positioned relative to the transmitter 16 so as to produce a relatively small angle θ between the transmitted beam 34 and the portion of the reflected beam impinging upon the receiver 18. In order to insure that the two photodiode detectors 102 and 104 are sensing light scattered from the same area, a beam splitter 108 will be used to direct half of the reflectively scattered light to one photodiode, and half to the other. The use of a beam splitter also serves to eliminate any angular variations within the plane of incidence. This helps to insure that the difference in distance is the only factor that affects the relative intensities of the light received by the photodiodes.

[0022] The structure of receiver 18 further comprises light passages 110 and 112 having light absorbing walls 114 for coupling the beam splitter 108 with detectors 102 and 104. The light absorbing walls 114 may further include baffling to further reduce light reflected to the detectors 102 and 104. The incident light beam 34 can be generated by a light emitting diode or semiconductor laser 116 located within the transmitter 16, and is subsequently collimated by a lens 118 to produce a light beam 34 that maintains a constant diameter of approximately one inch over a distance of 6 to 30 inches. The collimated beam 34 is then scattered in all directions by a reflecting surface 120, i.e., the vehicle occupant 24 if present.

[0023] Suppose that the distance between detectors 102 and 104 is L, and the distance from the point of reflective scattering to the closest photodiode 102 is x. Thus, under the principle of $1/r^2$, the intensity of the scattered light at the closer detector 102 is proportional to $1/x^2$, and the intensity of the scattered light at the other detector 104 is proportional to $1/(x+L)^2$. If the field of view is the same for both detectors, then:

$$I_1/I_2 = (x+L)^2/x^2 \rightarrow x = L/[(I_1/I_2)^{0.5}-1].$$

Thus, the ratio of the intensities sensed by the two photodiodes 102 and 104 serves as a measure of the distance x to the vehicle occupant.

[0024] It is noted that the $1/r^2$ relationship holds only for light that is randomly scattered from an object. The intensity of light that is specularly reflected does not diminish as a function of distance in the same way as scattered light. Fortunately, the specularly reflected light can be screened out by using polarizers. Since specularly reflected light tends to retain the polarization of the incident light, the incident light can be polarized in a particular direction, e.g., vertical, and the reflectively scattered light can be polarized in the complementary direction (horizontal). Because the reflectively scattered light is randomly polarized, polarization of the scattered light should permit about half of the light intensity to reach the detectors 102 and 104.

[0025] Referring to Figs. 3(a)-(c), there is shown a second embodiment 200 for determining the position of an occupant based on triangulation of the received light intensity. Elements previously described have like reference numbers. More specifically, the collimated beam 34 which is scattered in all directions by the reflecting surface 120, i.e., the occupant, is focused by an imaging lens 202 to form a relatively small spot 204 on a Bi-cell detector 206. As shown in Fig. 3(b), the Bi-cell detector 206 comprises a pair of adjacent photodiode detectors 208 and 210. Since the lens 202 aperture selects the fraction of the scattered light that reaches the detector 206, the spot 204 on the detector moves when the angle α between the axis of beam 34 and the axis of the reflectively scattered light that reaches the detector changes, as shown in Fig. 3(c).

[0026] The direction of the reflected rays reaching the photodiode detectors 208 and 210 is determined by the positions of the center of the imaging lens 202 and the point where the reflecting surface 120 cuts the incident beam 32. Thus, the particular angle α at which light is received at the photodiodes 208 and 210 depends only on the distance x to the reflecting surface. This angle is determined by tan α = b/x, where x is the distance from

the source to the reflecting surface, and b is a predetermined lateral separation of the transmitter and the detector. As the angle α varies, the relative amounts of radiant flux received by the two diodes 208 and 210 also varies. The diodes 208 and 210 generate respective current outputs I_1 and I_2 proportional to the relative amounts of light received by the diodes. Signal processing of the detector output currents comprises calculating the amplitude-independent ratio of currents to correct for reflection variation at the scattering surface 120. The ratio of the relative intensities determines the location of the spot 204 to provide a good measure of the angle α, and hence the distance x to the reflecting surface 120.

[0027] Referring to Figs. 4(a)-(c), there is shown a third embodiment 300 for determining the position of an occupant which employs triangulation of the received light intensity similar to embodiment 200, but replaces the Bi-cell detector 206 with a position sensitive detector (PSD) 302. The PSD 302, as shown in Fig. 4(b), is a distributed photosensitive device for which the difference in output currents I_1 and I_2 from the top and bottom ends 304 and 306 provides a linear measure of the spot's vertical position. As shown in Fig. 4(c), when the angle α varies, the position at which the reflected light is imaged will vary across the PSD 302. The ratio of the two current outputs I_1 and I_2 varies as the center of light intensity moves across the PSD 302, and therefore provides a measure of the angle α. The distance x to the occupant 24 can then be determined in a like manner as embodiment 200, described hereinabove.

[0028] As shown in Fig. 5, a second receiver 308 having a Bi-cell detector or PSD 310, and a imaging lens 312, can be located on the opposite side of the collimated incident beam 34 from the first Bi-cell detector 206, or PSD 302. The arrangement shown in Fig. 5 can provide a more accurate detection of the occupant's position because the use of the additional receiver 308 located on the opposite side of the incident beam 34 compensates for shifts in the scattering angle caused by variations in reflectivity across the incident beam. More specifically, variations in reflectivity of the reflecting surface shift the center of the reflectively scattered light beam from the geometric center of the light beam. The shift in the center point can change the angle of the received light beam. The use of two separate receivers located on opposite sides of the incident beam allows the system 10 to make an accurate determination of distance despite any shifts in the center of the reflectively scattered light beam.

[0029] In accordance with the present invention, signal processor/discrimination unit 26 utilizes a parameter based algorithm which is capable of analyzing the information indicative of occupant position generated by the optical position detector 12 to determine crash situations, and/or adjust discrimination parameters. The data from optical position detector 12 can be stored and subsequently tracked relative to the fixed vehicle interior structure by signal processor 26 to determine various discrimination parameters such as occupant presence, occupant velocity (change in occupant distance over a period of time), occupant acceleration (change in occupant velocity over a period of time), and various occupant seating conditions, e.g., distance from potential impacts points such as the steering wheel or dashboard, occupant in a potentially dangerous position relative to the potential impact points, and occupant use of a seat belt. Determination of the use of a seat belt can be predicted based on the measured occupant velocity or acceleration.

[0030] Further, decision parameters such as the particular decision window allowable for performing a discrimination analysis can be adjusted in accordance with the specific detected occupant condition to improve the efficiency of the discrimination analysis and the actuation of the safety restraint. Also, since the processor 26 stores and tracks the position information with respect to time, irrelevant occupant movements, such as hand waving, arm movement, etc., can be differentiated from movement caused by a crash situation. This is illustrated in Fig. 6(a), which shows a plot of occupant position-versus-time data representative of an arm waving relative to a fixed structure within the vehicle, and Fig. 6(b), which shows a plot of data representing an occupant during a crash situation relative to the same fixed structure. Therefore, with the present invention, the vehicle crash discrimination system 10 is designed to provide high frequency measurements of the position of the driver and/or passengers relative to potential impact points such as the steering wheel and dashboard, and to process that information so as to optimize the safety restraint deployment decision. The system can refrain from deploying an airbag when a person is too close. The explosive force with which an airbag is inflated is capable of doing substantial harm to a person who is in close proximity to the airbag. Thus, the present invention can prevent injuries by refraining from deploying the airbag.

[0031] The system 10 also measures the actual position, velocity, and acceleration of the occupants relative to the potential impact points within the vehicle, and using these measurements in conjunction with advanced signal processing techniques, the present invention greatly increases the amount of information useful in the deployment decision. The present invention also significantly improves the crash discrimination analysis by supplying position information of a vehicle occupant which can be used in real time to adjust decision parameters such as allowable time-to-fire time periods and threshold values. The ability to adjust decision parameters allows the system to customize deployment decisions to suit specific occupant situations.

[0032] It is worth illustrating this aspect of the present invention with several examples. Consider, first, a marginally low velocity crash in which the vehicle occupant is wearing a seat belt. If there is no information concerning the actual motion of the occupant available to the discrimination analysis, the discrimination system must

make a worst-case assumption, i.e., no seat belt usage, and deploy the airbag. Since the seat belt prevents the occupant from striking anything with injury-causing force, deployment of the airbag in this situation is actually unnecessary, and undesired.

[0033] In a second situation, a driver may sit closer than average to the steering wheel, but still outside the inflation zone. The actual time-to-fire an airbag in this situation is less than the standard required time-to-fire; since that standard is based on the time it takes the average person sitting an average distance away from the steering wheel to move within the inflation zone. By measuring the actual distance to the person, the present invention can adjust the decision window of the discrimination analysis to shorten the actual time-to-fire and deploy the airbag somewhat early to protect the driver from hitting the steering wheel, and to prevent injury from the inflating airbag. In addition, threshold values used in the discrimination analysis can be reduced in response to a driver sitting closer than average to the steering wheel.

[0034] In a third situation, a driver may sit at a somewhat greater than average distance from the steering wheel. In this situation, the actual time-to-fire the airbag is preferably longer than the standard required time-to-fire. The decision window of the discrimination analysis can then be adjusted to lengthen the actual time-to-fire to provide additional time in the discrimination analysis for analyzing more information. The ability to analyze more information provides a more reliable decision. Further, threshold values used in the discrimination analysis can be increased because of the increased distance between the driver and the potential impact point.

[0035] It is further noted that if a plurality of occupant position detectors are installed in the vehicle along with data recording devices, an analytical study can be made by tracing how human bodies move in response to real world crashes. Thus, the occupant position information retrieved from the recording devices can generate more detailed knowledge of how people move in crashes, and the ability to trace that movement in real time could lead to the development of new advances in passenger safety restraints.

[0036] Referring now to Fig. 7, there is shown a further embodiment of the passenger condition discrimination system 10 incorporating a supplemental optical, low threshold safing sensor 400. The safing sensor 400 comprises a housing 402 having a cylindrical passage 404 formed therein, and a magnetic sensing mass 402 in the passage 404 which is magnetically biased by a magnetically permeable element 408 to an initial position against a stop element 410 located at a first end within the passage 404. The sensing mass 406 is displaced in response to acceleration of the housing 402 from the initial position to a second position within the passage when such acceleration overcomes the magnetic bias of the sensing mass. Damping means such as an electrically conductive ring 412, for example a copper tube, encompasses the passage 404 to provide magnetic damping for the sensing mass 406 during the displacement of the magnetic sensing mass within the passage 404. The magnetic sensing mass 406 of safing sensor 400 functions in a manner similar to the magnetically-damped, testable accelerometer as taught in commonly assigned U. S. Patent 4,077,091 to Behr, incorporated herein by reference.

[0037] As shown in Fig. 7, a portion of the collimated incident beam 34 is supplied by suitable optical coupling structure such as a beam splitter 414 and mirror 416, or alternatively a fiber optic cable, to a second end of the passage 404. The collimated incident beam is horizontally redirected down the passage 404 where the beam is reflectively scattered by a scattering surface 418 of known reflectivity, e.g., cloth, affixed to an end face of the sensing mass 406. A receiver 420 comprising an infrared detector 422 and synchronous demodulator 424 is positioned relative to second end of the passage 404 so as to receive at least a portion of the reflectivity scattered light. The distance d of the sensing mass 406 relative to the fixed incident light source can be calculated by detecting the intensity of the scattered light as described hereinabove with respect to Figs. 2-4. The data obtained by the synchronous demodulator 424 is provided as an output 426 to the signal processor/ discrimination unit 26 for storage and/or analysis.

[0038] The safing sensor 400 of the present invention provides several advantageous functions for the vehicle crash discrimination system 10. First, the safing sensor 400 provides a way of calibrating the system 10. The intensity of the light scattered by the sensing mass 406 while at the initial position will be substantially constant, thereby allowing corrections or adjustments to the transmission of the incident light beam 34. Further, since the scattering surface 418 affixed to the end of the sensing mass 406 has a known reflectivity, the system 10 will be able to detect a condition where an occupant is providing a low reflection of the incident beam 34, such as an occupant wearing a material of low reflectivity like black velvet, based on a comparison of the respective outputs 22 and 426. Thus, the system 10 can make appropriate corrections for the occupant's low reflectivity.

[0039] Second, the safing sensor 400 supplements the signal processor/discrimination unit 26 in discerning spurious occupant movement, such as a hand waving in front of the receiver 18. Signal processor 26 may detect movement of the occupant because of the data generated by receiver 18. However, if the sensing mass 406 in the safing sensor 400 does not move, the signal processor 26 can assume the occupant movement was not in response to vehicle acceleration.

[0040] Third, the safing sensor 400 provides additional data for use in the discrimination analysis since the data generated at output 426 in response to the movement of the sensing mass 406 can be differentiated twice with respect to time to determine vehicle acceleration. Vehicle acceleration data can then be utilized with the occupant condition/position data in the parameter

based algorithm to provide more reliable crash discriminations and safety restraint actuations.

[0041] Preferably, the distance measurement of the sensing mass 406 movement should be based on how a frictionless sensing mass would react to vehicle acceleration. However, as described hereinabove, the safing sensor 400 employs both biasing and damping of the sensing mass 406 to permit the sensor 400 to be unaffected by conditions such as very low threshold crashes and rough road conditions. The biasing and damping of the sensing mass 406 provides inexact motion measurement data for signal processor unit 26. The effects of the biasing and damping on the sensing mass movement are well understood, and therefore in the present invention, the signal processor unit 26 preferably modifies the data from output 426 with a factor which effectively "undamps" the data before use in the discrimination analysis. Thus, a movement measurement based on a "frictionless" sensing mass is obtainable with the above described safing sensor 400.

[0042] While the preferred embodiments have been described using an active infrared position detector 12, it will be appreciated that an acceptable alternative active, or passive, sensing arrangement utilizing ultrasonic sensors or microwave sensors could be employed. It will be further understood that the foregoing description of the preferred embodiment of the present invention is for illustrative purposes only, and that the various structural and operational features herein disclosed are susceptible to a number of modifications, none of which departs from the spirit and scope of the present invention as defined in the appended claims.

Claims

1. A method for optimizing a discrimination analysis used in a system for actuating a vehicle occupant safety restraint (38) in response to a vehicle collision comprising the steps of:

   continuously detecting a static position of a vehicle occupant (24) relative to a fixed structure within the vehicle; and
   adjusting a discrimination threshold value used in the discrimination analysis for determining whether actuation of the safety restraint (38) is required based on the detected static occupant position;

   characterized in that said method further comprises the step of differentiating irrelevant occupant movements from movement caused by a crash situation based solely on the variation of said detected static occupant position with time and said discrimination threshold value is also adjusted based on the result of said differentiating step.

2. The method of claim 1 further comprising the steps of:

   detecting a change in the detected static occupant position;
   determining the velocity of the occupant (24) based on the change in the detected static occupant position;
   comparing the occupant velocity to the discrimination threshold value; and
   actuating the safety restraint (38) if the occupant velocity exceeds the threshold value and the change in the detected static occupant position is not differentiated as an irrelevant occupant movement.

3. The method of claim 1 further comprising the steps of:

   receiving data representative of vehicle acceleration;
   comparing the data representative of vehicle acceleration to the discrimination threshold value; and
   actuating the safety restraint (38) if the data representative of vehicle acceleration exceeds the threshold value.

4. The method of claim 2 further comprising the steps of:

   receiving data representative of vehicle acceleration;
   adjusting an acceleration discrimination threshold value based on the detected static occupant position and the result of said differentiating step;
   comparing the data representative of vehicle acceleration to the acceleration discrimination threshold value;
   and actuating the safety restraint (38) if the data representative of vehicle acceleration exceeds the acceleration discrimination threshold value.

5. The method of any one of claims 1 to 4 wherein the step of continuously detecting the position of a vehicle occupant (24) comprises the steps of:

   transmitting a beam of light (34) at a designated area within the vehicle potentially occupied by a person;
   receiving at least a portion of the light beam which is reflectively scattered by a surface within the designated area;
   measuring an intensity level of at least a portion of the received light beam, or an angle from which the light beam is received; and
   determining the distance between the scatter-

ing surface and a fixed structure within the vehicle based on the measured intensity level or angle.

6. The method of claim 5 wherein the step of determining the distance between the scattering surface and the fixed structure comprises:

detecting the intensity level of the reflectively scattered light beam (34) at two different locations separated by a predetermined distance; and
determining the distance between the scattering surface and the fixed structure based on a ratio of the intensity levels detected at the two different positions.

7. The method of claim 5 wherein the step of determining the distance between the scattering surface and the fixed structure comprises:

transmitting the beam of light (34) from a first location within the vehicle;
imaging the reflectively scattered light beam to form a spot on a detector means located at a second location, the first and second locations being separated by a predetermined distance, said detector means providing an output indicative of the location of the spot on said detector means;
determining an angle from which the reflectively scattered light beam is received based on the location of the spot on the detector means; and
determining the distance between the scattering surface and the fixed structure based on the angle from which the reflectively scattered light is received.

8. The method of claim 5 wherein the imaging step comprises imaging the reflectively scattered light beam (34) to form a spot on each of a plurality of detector means positioned and oriented to receive the reflectively scattered light at different respective angles; and
determining the distance between the scattering surface and the fixed structure based on the plurality of determined angles, thereby reducing any effect on the reflectively scattered light beam from varying reflectance patterns on the scattering surface.

9. The method of any one of claims 5 to 8 further comprising the steps of:

directing at least a portion of the light beam (34) at a first end of an inertial sensing mass (406) in a means for sensing the acceleration (400) of the vehicle, said inertial sensing mass (406) being movable from a first position to a second position in response to an applied acceleration force, said first end comprising a material (418) having a known reflectivity;
measuring an intensity level of at least a portion of the light beam (34) which is reflectively scattered by the first end of the inertial sensing mass (406); and
detecting movement of the inertial sensing mass (406) from the first position to the second position based on the measured intensity level of the light reflectively scattered by the first end of the inertial sensing mass.

10. A method of actuating a vehicle safety restraint (38) comprising the steps of the method of any one of claims 1 to 4 and further comprising the steps of:

transmitting a beam of light (34) at a designated area within the vehicle potentially occupied by a person (24);
measuring a relative intensity level or average of scattering angles of at least a portion of the light beam (34) which is reflectively scattered by a surface within the designated area;
determining the distance between the scattering surface and a fixed structure within the vehicle based on the measured relative intensity level or average of scattering angles to thereby perform said step of continuously detecting;
determining a change in the static occupant position over a period of time;
comparing the change in said static occupant position over a period of time to said threshold value; and
actuating the safety restraint if the change in distance exceeds the threshold value and the change in the detected static occupant position is not differentiated as an irrelevant occupant movement.

11. A system for actuating a vehicle occupant safety restraint (38) in response to a vehicle collision comprising:

means for continuously detecting a static position of a vehicle occupant (24) relative to a fixed structure within the vehicle; and
processor means comprising:

a means for discriminating a vehicle crash requiring actuation of the occupant safety restraint (38), said discrimination means having a discrimination threshold value for use in the discrimination analysis; and a means responsive to the data representative of the detected static occupant position for adjusting the discrimination threshold

value;
said system characterised in that said processor means further comprises a means for differentiating irrelevant occupant movement from movement caused by a crash situation and said means for differentiating differentiates according to solely the variation of said detected static position with time.

12. The system of claim 11 wherein said processor means further comprises:

means for detecting a change in the detected static occupant position;
means for determining the velocity of the occupant (24) based on the detected change in detected static occupant position;
means for comparing the occupant velocity to the discrimination threshold value; and
means for actuating the safety restraint (38) if the occupant velocity exceeds the threshold value and the change in the detected static occupant position is not differentiated as an irrelevant occupant movement.

13. The system of claim 11 further comprising:

means for receiving data representative of vehicle acceleration (400); and
said processor means further comprising a means for comparing the data representative of vehicle acceleration to the discrimination threshold value, and means for actuating the safety restraint (38) if the data representative of vehicle acceleration exceeds the threshold value.

14. The system of claim 11 further comprising:

means for receiving data representative of vehicle acceleration (400); and
said means for discriminating further comprises an acceleration discrimination threshold value for use in the discrimination analysis and a means responsive to the data representative of the detected static occupant position for adjusting the acceleration discrimination threshold value; and
said processor means further comprising a means for comparing the data representative of vehicle acceleration to the acceleration discrimination threshold value, and means for actuating the safety restraint (38) if the data representative of vehicle acceleration exceeds the acceleration threshold value.

15. The system of any one of claims 11 to 14 wherein said position detecting means comprises:

means for transmitting a beam of light (16) at designated area within the vehicle potentially occupied by a person;
means for receiving at least a portion of the light beam (18) which is reflectively scattered by a surface within the designated area;
means for measuring an intensity level (102,104,206,208,210,310) of at least a portion of the received light beam, or an angle from which the light beam is received; and
means for determining the distance between the scattering surface and a fixed structure within the vehicle based on the measured intensity level or angle.

16. The system of claim 15 further comprising:

means for sensing the acceleration (400) of the vehicle having an inertial sensing mass (406) movable from a first position to a second position in response to an applied acceleration force, said inertial sensing mass (406) having a first end comprising a material (418) of known reflectivity;
means for directing at least a portion of the transmitted light beam (34) at said first end of said inertial sensing mass (406);
means for measuring an intensity level of at least a portion of the light beam which is reflectively scattered by said first end; and
means for detecting movement of said inertial sensing mass (406) from the first position to the second position based on the measured intensity level of the light reflectively scattered by said first end.

17. The system of any one of claims 11 to 13 wherein said position detecting means comprises:

means for transmitting a beam of light (34) at a designated area within the vehicle potentially occupied by a person;
means for receiving at least a portion of the light beam which is reflectively scattered by a surface within the designated area;
means for detecting the intensity level of the received light beam at two different locations separated by a predetermined distance; and
means for determining the distance between the scattering surface and the fixed structure based on a ratio of the intensity levels detected at the two different locations.

18. The system of any one of claims 11 to 13 wherein said position detecting means comprises:

means positioned at a first location within the vehicle for transmitting a beam of light (34) at a designated area within the vehicle potentially occupied by a person (24);
a detector means positioned at a second location, the first and second location being separated by a predetermined distance;
means for imaging at least a portion of the light beam which is reflectively scattered to form a spot on said detector means, said detector means providing an output indicative of the location of the spot on said detector means;
means responsive to said detector means output for determining an angle from which the reflectively scattered light beam is received; and
means for determining the distance between the scattering surface and the fixed structure based on the determined angle.

19. The system of any one of claims 11 to 13 wherein said position detecting means comprises:

means positioned at a first location within the vehicle for transmitting a beam of light (34) at a designated area within the vehicle potentially occupied by a person (24);
a plurality of detector means each positioned at different locations, each different location being separated from the first location by a predetermined distance;
means for imaging at least a portion of the light beam which is reflectively scattered to form a spot on each of said plurality of detector means, said plurality of detector means providing an output indicative of the location of the spot respectively formed thereon;
means responsive to said plurality of detector means outputs for determining an angle from which the reflectively scattered light beam is respectively received at each of said plurality of detector means; and
means for determining the distance between the scattering surface and the fixed structure based on the plurality of determined angles, thereby reducing any effect on the reflectively scattered light beam (34) from varying reflectance patterns on the scattering surface.

Patentansprüche

1. Verfahren zum Optimieren einer Unterscheidungsanalyse, die in einer Anlage zum Betätigen einer Fahrzeuginsassen-Rückhaltevorrichtung (38) bei einem Fahrzeugaufprall benutzt wird, mit den Arbeitsschritten:

- kontinuierliches Erfassen einer statischen Position eines Fahrzeuginsassen (24) in bezug auf eine feststehende Struktur innerhalb des Fahrzeugs, und
- Einstellen eines Unterscheidungsschwellwertes, der in der Unterscheidungsanalyse zum Bestimmen der Notwendigkeit einer Betätigung der Sicherheitsrückhaltevorrichtung (38) anhand der erfaßten statischen Fahrzeuginsassenposition benutzt wird,

dadurch gekennzeichnet, daß das Verfahren ferner den Arbeitsschritt des Unterscheidens zwischen belanglosen Bewegungen des Fahrzeuginsassen und einer durch eine Aufprallsituation hervorgerufenen Bewegung allein anhand der zeitlichen Änderung der genannten erfaßten statischen Fahrzeuginsassenposition umfaßt, und daß der Unterscheidungsschwellwert ebenfalls an das Ergebnis des genannten Unterscheidungsschrittes angepaßt wird.

2. Verfahren nach Anspruch 1, ferner mit den Arbeitsschritten:

- Feststellen einer Änderung der erfaßten statischen Fahrzeuginsassenposition,
- Bestimmen der Geschwindigkeit des Fahrzeuginsassen (24) anhand der Änderung der erfaßten statischen Fahrzeuginsassenposition,
- Vergleichen der Fahrzeuginsassengeschwindigkeit mit dem Unterscheidungsschwellwert, und
- Betätigen der Sicherheitsrückhaltevorrichtung (38), wenn die Fahrzeuginsassengeschwindigkeit den Schwellwert übersteigt und die Änderung der erfaßten statischen Fahrzeuginsassenposition nicht als eine belanglose Bewegung des Fahrzeuginsassen erkannt wird.

3. Verfahren nach Anspruch 1, ferner mit den Arbeitsschritten:

- Empfangen von die Fahrzeugbeschleunigung darstellenden Daten,
- Vergleichen der die Fahrzeugbeschleunigung darstellenden Daten mit dem Unterscheidungsschwellwert, und
- Betätigen der Sicherheitsrückhaltevorrichtung (38), wenn die die Fahrzeugbeschleunigung darstellenden Daten den Schwellwert übersteigen.

4. Verfahren nach Anspruch 2, ferner mit den Arbeitsschritten:

- Empfangen von die Fahrzeugbeschleunigung darstellenden Daten,

- Einstellen eines Beschleunigungs-Unterscheidungsschwellwertes anhand der erfaßten statischen Fahrzeuginsassenposition und des Ergebnisses des genannten Unterscheidungsschrittes,
- Vergleichen der die Fahrzeugbeschleunigung darstellenden Daten mit dem Beschleunigungs-Unterscheidungsschwellwert, und
- Betätigen der Sicherheitsrückhaltevorrichtung (38), wenn die die Fahrzeugbeschleunigung darstellenden Daten den Beschleunigungs-Unterscheidungsschwellwert übersteigen.

5. Verfahren nach einem der Ansprüche 1 bis 4, bei dem der Schritt des kontinuierlichen Erfassens der Position eines Fahrzeuginsassen (24) die Arbeitsschritte umfaßt:

   - Senden eines Lichtstrahls (34) gegen einen bezeichneten Bereich innerhalb des Fahrzeugs, der von einer Person eingenommen werden kann,
   - Empfangen wenigstens eines Teils des Lichtstrahls, der von einer Fläche innerhalb des bezeichneten Bereichs durch Reflexion gestreut wird,
   - Messen eines Intensitätsgrades wenigstens eines Teils des empfangenen Lichtstrahls oder eines Winkels, unter dem der Lichtstrahl empfangen wird, und
   - Bestimmen des Abstandes zwischen der Streufläche und einer feststehenden Struktur innerhalb des Fahrzeugs anhand des gemessenen Intensitätsgrades oder Winkels.

6. Verfahren nach Anspruch 5, bei dem der Schritt des Bestimmens des Abstandes zwischen der Streufläche und der feststehenden Struktur umfaßt:

   - Feststellen des Intensitätsgrades des durch Reflexion gestreuten Lichtstrahls (34) an zwei verschiedenen, durch einen vorbestimmten Abstand voneinander getrennten Stellen, und
   - Bestimmen des Abstandes zwischen der Streufläche und der feststehenden Struktur anhand eines Verhältnisses der an den beiden verschiedenen Stellen festgestellten Intensitätsgrade zueinander.

7. Verfahren nach Anspruch 5, bei dem der Schritt des Bestimmens des Abstandes zwischen der Streufläche und der feststehenden Struktur umfaßt:

   - Senden des Lichtstrahls (34) von einer ersten Stelle innerhalb des Fahrzeugs,
   - Abbilden des durch Reflexion gestreuten Lichtstrahls als Fleck an einer an einer zweiten Stelle angeordneten Detektoreinrichtung, wobei die erste und die zweite Stelle durch einen vorbestimmten Abstand voneinander getrennt sind, die genannte Detektoreinrichtung einen den Ort des Flecks an der Detektoreinrichtung anzeigenden Ausgang liefert,
   - Bestimmen eines Winkels, unter dem der durch Reflexion gestreute Lichtstrahl empfangen wird, anhand des Ortes des Flecks an der Detektoreinrichtung, und
   - Bestimmen des Abstandes zwischen der Streufläche und der feststehenden Struktur anhand des Winkels, unter dem das durch Reflexion gestreute Licht empfangen wird.

8. Verfahren nach Anspruch 5, bei dem der Abbildungsschritt umfaßt:

   - Abbilden des durch Reflexion gestreuten Lichtstrahls (34) als Fleck an jeder Detektoreinrichtung einer Vielzahl Detektoreinrichtungen die so angeordnet und ausgerichtet sind, daß sie das durch Reflexion gestreute Licht je unter einem verschiedenen Winkel empfangen, und
   - Bestimmen des Abstandes zwischen der Streufläche und der feststehenden Struktur anhand der Vielzahl der bestimmten Winkel, wodurch jegliche Wirkung auf den durch Reflexion gestreuten Lichtstrahl durch veränderliche Reflexionsmuster an der Streufläche gemildert wird.

9. Verfahren nach einem der Ansprüche 5 bis 8, ferner mit den Arbeitsschritten:

   - Richten wenigstens eines Teils des Lichtstrahls (34) gegen ein erstes Ende einer Trägheitssensormasse (406) in einer Einrichtung (400) zum Erfassen der Fahrzeugbeschleunigung, wobei die Trägheitssensormasse (406) aus einer ersten Stellung in eine zweite in Abhängigkeit von einer ausgeübten Beschleunigungskraft bewegbar ist, wobei das genannte erste Ende einen Werkstoff (418) von bekanntem Reflexionsvermögen aufweist,
   - Messen eines Intensitätsgrades wenigstens eines Teils des Lichtstrahls (34), der durch das erste Ende der Trägheitssensormasse (406) durch Reflexion gestreut wird, und
   - Feststellen der Bewegung der Trägheitssensormasse (406) aus der ersten Stellung in die zweite anhand des gemessenen Intensitätsgrades des durch das erste Ende der Trägheitssensormasse durch Reflexion gestreuten Lichts.

10. Verfahren zum Betätigen einer Fahrzeug-Sicherheitsrückhaltevorrichtung (38) mit den Arbeitsschritten des Verfahrens gemäß einem der Ansprü-

che 1 bis 4 und den weiteren Arbeitsschritten:

- Senden eines Lichtstrahls (34) gegen einen bezeichneten Bereich innerhalb des Fahrzeugs, der von einer Person (24) eingenommen werden kann,
- Messen eines relativen Intensitätsgrades oder eines Durchschnittswertes von Streuwinkeln wenigstens eines Teils des Lichtstrahls (34), der durch eine Fläche innerhalb des bezeichneten Bereichs durch Reflexion gestreut wird,
- Bestimmen des Abstandes zwischen der Streufläche und einer feststehenden Struktur innerhalb des Fahrzeugs anhand des gemessenen relativen Intensitätsgrades oder des Durchschnittswertes der Streuwinkel, um dadurch den genannten Schritt des kontinuierlichen Erfassens auszuführen,
- Bestimmen einer Änderung der statischen Fahrzeuginsassenposition über einen Zeitraum,
- Vergleichen der Änderung der statischen Fahrzeuginsassenposition über einen Zeitraum mit dem genannten Schwellwert, und
- Betätigen der Sicherheitsrückhaltevorrichtung, wenn die Abstandsänderung den Schwellwert übersteigt und die Änderung der erfaßten statischen Fahrzeuginsassenposition nicht als belanglose Bewegung des Fahrzeuginsassen erkannt wird.

11. Anlage zum Betätigen einer Fahrzeuginsassen-Sicherheitsrückhaltevorrichtung (38) bei einem Fahrzeugaufprall, mit

- einer Einrichtung zum kontinuierlichen Erfassen einer statischen Position eines Fahrzeuginsassen (24) in bezug auf eine feststehende Struktur innerhalb des Fahrzeugs, und
- einer Prozessoreinrichtung mit

einer Einrichtung zum Unterscheiden eines Fahrzeugaufpralls, der die Betätigung der Fahrzeuginsassen-Sicherheitsrückhaltevorrichtung (38) erfordert, wobei die Unterscheidungseinrichtung über einen im voraus festgelegten Unterscheidungsschwellwert zur Benutzung in der Unterscheidungsanalyse verfügt, und einer auf die die erfaßte statische Fahrzeuginsassenposition darstellenden Daten ansprechenden Einrichtung zum Einstellen des Unterscheidungsschwellwertes, dadurch gekennzeichnet, daß die Prozessoreinrichtung ferner eine Einrichtung zum Unterscheiden belangloser Fahrzeuginsassenbewegungen von Bewegungen aufweist, die durch eine Aufprallsituation hervorgerufen werden, und die genannte Einrichtung zum Unterscheiden allein nach der zeitlichen Änderung der genannten erfaßten statischen Position unterscheidet.

12. Anlage nach Anspruch 11, bei der die Prozessoreinrichtung ferner umfaßt:

- eine Einrichtung zum Feststellen einer Änderung der erfaßten statischen Fahrzeuginsassenposition,
- eine Einrichtung zum Bestimmen der Geschwindigkeit des Fahrzeuginsassen (24) anhand der festgestellten Änderung der erfaßten statischen Fahrzeuginsassenposition,
- eine Einrichtung zum Vergleichen der Fahrzeuginsassengeschwindigkeit mit dem Unterscheidungsschwellwert, und
- eine Einrichtung zum Betätigen der Sicherheitsrückhaltevorrichtung (38), wenn die Fahrzeuginsassengeschwindigkeit den Schwellwert übersteigt und die Änderung der erfaßten statischen Fahrzeuginsassenposition nicht als belanglose Bewegung des Fahrzeuginsassen erkannt wird.

13. Anlage nach Anspruch 11, ferner mit

- einer Einrichtung (400) zum Empfangen von die Fahrzeugbeschleunigung darstellenden Daten, und
  bei der die genannte Prozessoreinrichtung ferner eine Einrichtung zum Vergleichen der die Fahrzeugbeschleunigung darstellenden Daten mit dem Unterscheidungsschwellwert und eine Einrichtung umfaßt, die die Sicherheitsrückhaltevorrichtung (38) betätigt, wenn die die Fahrzeugbeschleunigung darstellenden Daten den Schwellwert übersteigen.

14. Anlage nach Anspruch 11, ferner mit

- einer Einrichtung (400) zum Empfangen von die Fahrzeugbeschleunigung darstellenden Daten, und bei der
- die genannte Unterscheidungseinrichtung ferner über einen Beschleunigungs-Unterscheidungsschwellwert zur Benutzung in der Unterscheidungsanalyse verfügt und eine auf die die erfaßte statische Fahrzeuginsassenposition darstellenden Daten ansprechende Einrichtung zum Einstellen des Beschleunigungs-Unterscheidungsschwellwertes umfaßt, und
- die Prozessoreinrichtung ferner eine Einrichtung zum Vergleichen der die Fahrzeugbeschleunigung darstellenden Daten mit dem Beschleunigungs-Unterscheidungsschwellwert und eine Einrichtung umfaßt, die die Sicherheitsrückhaltevorrichtung (38) betätigt, wenn die die Fahrzeugbeschleunigung darstellenden Daten den Beschleunigungsschwellwert über-

steigen.

15. Anlage nach einem der Ansprüche 11 bis 14, bei der die Einrichtung zum Positionserfassen umfaßt:

- eine Einrichtung (16) zum Senden eines Lichtstrahls gegen einen bezeichneten Bereich innerhalb des Fahrzeugs, der von einer Person eingenommen werden kann,
- eine Einrichtung (18) zum Empfangen wenigstens eines Teils des Lichtstrahls, der durch eine Fläche innerhalb des bezeichneten Bereichs durch Reflexion gestreut wird,
- eine Einrichtung (102, 104; 206, 208, 210; 310) zum Messen eines Intensitätsgrades von wenigstens einem Teil des empfangenen Lichtstrahls oder eines Winkels, unter dem der Lichtstrahl empfangen wird, und
- eine Einrichtung zum Bestimmen des Abstandes zwischen der Streufläche und einer feststehenden Struktur innerhalb des Fahrzeugs anhand des gemessen Intensitätsgrades oder Winkels.

16. Anlage nach Anspruch 15, ferner mit

- einer Einrichtung (400) zum Erfassen der Fahrzeugbeschleunigung, mit einer Trägheitssensormasse (406), die aus einer ersten Stellung in eine zweite in Abhängigkeit von einer ausgeübten Beschleunigungskraft bewegbar ist, wobei die Trägheitssensormasse (406) ein erstes Ende aus einem Werkstoff (418) von bekanntem Reflexionsvermögen aufweist,
- einer Einrichtung zum Richten wenigstens eines Teils des gesendeten Lichtstrahls (34) gegen das erste Ende der Trägheitssensormasse (406),
- einer Einrichtung zum Messen eines Intensitätsgrades von wenigstens einem Teil des Lichtstrahls, der durch das genannte erste Ende durch Reflexion gestreut wird, und
- einer Einrichtung zum Feststellen einer Bewegung der Trägheitssensormasse (406) aus der ersten Stellung in die zweite anhand des gemessenen Intensitätsgrades des durch das genannte erste Ende durch Reflexion gestreuten Lichts.

17. Anlage nach einem der Ansprüche 11 bis 13, bei der die Einrichtung zum Positionserfassen umfaßt:

- eine Einrichtung zum Senden eines Lichtstrahls (34) gegen einen bezeichneten Bereich innerhalb des Fahrzeugs, der von einer Person eingenommen werden kann,
- eine Einrichtung zum Empfangen wenigstens eines Teils des Lichtstrahls, der durch eine Fläche innerhalb des bezeichneten Bereichs durch Reflexion gestreut wird,
- eine Einrichtung zum Bestimmen des Intensitätsgrades des empfangenen Lichtstrahls an zwei durch einen vorbestimmten Abstand voneinander getrennten verschiedenen Stellen, und
- eine Einrichtung zum Bestimmen des Abstandes zwischen der Streufläche und der feststehenden Struktur anhand eines Verhältnisses der an den beiden verschiedenen Stellen erfaßten Intensitätsgrade zueinander.

18. Anlage nach einem der Ansprüche 11 bis 13, bei der die Einrichtung zum Positionserfassen umfaßt:

- eine an einer ersten Stelle innerhalb des Fahrzeugs angeordnete Einrichtung zum Senden eines Lichtstrahls (34) gegen einen bezeichneten Bereich innerhalb des Fahrzeugs, der von einer Person (24) eingenommen werden kann,
- eine an einer zweiten Stelle angeordnete Detektoreinrichtung, wobei die erste und die zweite Stelle durch einen vorbestimmten Abstand voneinander getrennt sind,
- eine Einrichtung zum Abbilden wenigstens eines Teils des durch Reflexion gestreuten Lichtstrahls als Fleck an der genannten Detektoreinrichtung, wobei die Detektoreinrichtung einen den Ort des Flecks an der Detektoreinrichtung anzeigenden Ausgang liefert,
- eine auf den Ausgang der Detektoreinrichtung ansprechende Einrichtung zum Bestimmen eines Winkels, unter dem der durch Reflexion gestreute Lichtstrahl empfangen wird, und
- eine Einrichtung zum Bestimmen des Abstandes zwischen der Streufläche und der feststehenden Struktur anhand des bestimmten Winkels.

19. Anlage nach einem der Ansprüche 11 bis 13, bei der die Einrichtung zum Positionserfassen umfaßt:

- eine an einer ersten Stelle innerhalb des Fahrzeugs angeordnete Einrichtung zum Senden eines Lichtstrahls (34) gegen einen bezeichneten Bereich innerhalb des Fahrzeugs, der von einer Person (24) eingenommen werden kann,
- eine Vielzahl Detektoreinrichtungen, die je an verschiedenen Stellen angeordnet sind, wobei jede der verschiedenen Stellen von der ersten Stelle durch einen vorbestimmten Abstand getrennt ist,
- eine Einrichtung zum Abbilden wenigstens eines Teils des durch Reflexion gestreuten Lichtstrahls als Fleck an jeder Detektoreinrichtung aus der Vielzahl Detektoreinrichtungen, wobei die genannte Vielzahl Detektoreinrichtungen

einen Ausgang liefert, der den Ort des zugehörigen an ihnen erzeugten Flecks anzeigt,

- eine auf die Ausgänge der Vielzahl Detektoreinrichtungen ansprechende Einrichtung zum Bestimmen eines Winkels, unter dem der durch Reflexion gestreute Lichtstrahl von jeder Detektoreinrichtung aus der Vielzahl Detektoreinrichtungen empfangen wird, und
- eine Einrichtung zum Bestimmen des Abstandes zwischen der Streufläche und der feststehenden Struktur anhand der Vielzahl der bestimmten Winkel, wodurch jegliche Wirkung auf den durch Reflexion gestreuten Lichtstrahl (34) durch veränderliche Reflexionsmuster an der Streufläche gemildert wird.

Revendications

1. Procédé pour optimiser une analyse de discrimination dans un système pour actionner le dispositif de retenue (38) pour la sécurité d'un occupant d'un véhicule en réponse à une collision du véhicule comprenant les étapes consistant à :

    détecter, d'une façon continue, une position statique d'un occupant (24) d'un véhicule par rapport à une structure fixe située à l'intérieur du véhicule; et
    ajuster une valeur de seuil de discrimination utilisée dans l'analyse de discrimination pour déterminer si l'actionnement du dispositif de retenue (38) est nécessaire en se basant sur la position statique détectée de l'occupant;

    caractérisé en ce que ledit procédé comprend en outre l'étape consistant à différencier les mouvements non pertinents de l'occupant du mouvement provoqué par une situation de collision en se basant seulement sur la variation de ladite position statique détectée de l'occupant dans le temps et ladite valeur de seuil de discrimination est également ajustée en fonction du résultat de ladite étape de différenciation.

2. Procédé selon la revendication 1, comprenant, en outre, les étapes consistant à :

    détecter une variation dans la position statique détectée de l'occupant;
    déterminer la vitesse de l'occupant (24) en se basant sur la variation de la position statique détectée de l'occupant;
    comparer la vitesse de l'occupant avec la valeur de seuil de discrimination; et
    actionner le dispositif de retenue pour sécurité (38) si la vitesse de l'occupant dépasse la valeur de seuil et si la variation de la position statique détectée de l'occupant n'est pas différenciée comme étant un mouvement non pertinent de l'occupant.

3. Procédé selon la revendication 1, comprenant, en outre, les étapes consistant à :

    recevoir des données représentatives d'une accélération du véhicule;
    comparer les données représentatives de l'accélération du véhicule avec la valeur de seuil de discrimination; et
    actionner le dispositif de retenue (38) pour sécurité si les données représentatives de l'accélération du véhicule dépassent la valeur de seuil.

4. Procédé selon la revendication 2, comprenant, en outre, les étapes consistant à :

    recevoir des données représentatives d'une accélération du véhicule;
    ajuster une valeur de seuil de discrimination d'accélération en se basant sur la position statique détectée de l'occupant et sur le résultat de ladite étape de différenciation;
    comparer les données représentatives de l'accélération du véhicule avec la valeur de seuil de discrimination d'accélération;
    et actionner le dispositif de retenue (38) pour sécurité si les données représentatives de l'accélération du véhicule dépassent la valeur de seuil de discrimination d'accélération.

5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel l'étape de détection, d'une façon continue, de la position de l'occupant (24) du véhicule comprend les étapes consistant à :

    émettre un faisceau lumineux (34) vers une zone désignée située à l'intérieur du véhicule et occupée potentiellement par une personne;
    recevoir au moins une partie du faisceau lumineux qui est diffusé par réflexion par une surface située à l'intérieur de la zone désignée;
    mesurer le niveau d'intensité d'au moins une partie du faisceau lumineux reçu, ou l'angle sous lequel est reçu le faisceau lumineux; et
    déterminer la distance entre la surface de diffusion et une structure fixe située à l'intérieur du véhicule en se basant sur le niveau d'intensité ou sur l'angle mesuré.

6. Procédé selon la revendication 5, dans lequel l'étape de détermination de la distance entre la surface de diffusion et la structure fixe consiste à :

    détecter, en deux endroits différents séparés

par une distance prédéterminée, le niveau d'intensité du faisceau lumineux (34) diffusé par réflexion; et
déterminer la distance entre la surface de diffusion et la structure fixe en se basant sur le rapport des niveaux d'intensité détectés aux deux positions différentes.

7. Procédé selon la revendication 5, dans lequel l'étape de détermination de la distance entre la surface de diffusion et la structure fixe consiste à :

émettre le faisceau lumineux (34) à partir d'un premier endroit situé à l'intérieur du véhicule;
focaliser le faisceau lumineux diffusé par réflexion de manière à former un point lumineux sur un moyen détecteur situé à un second endroit, les premier et second endroits étant séparés par une distance prédéterminée, ledit moyen détecteur fournissant un signal de sortie indicatif de l'endroit du point lumineux sur ledit détecteur;
déterminer l'angle sous lequel le faisceau diffusé par réflexion est reçu en se basant sur l'endroit du point lumineux sur le moyen détecteur; et
déterminer la distance entre la surface de diffusion et la structure fixe en se basant sur l'angle sous lequel la lumière diffusée par réflexion est reçue.

8. Procédé selon la revendication 5, dans lequel l'étape de focalisation consiste à focaliser le faisceau lumineux (34) diffusé par réflexion de manière à former un point lumineux sur chaque moyen détecteur d'une pluralité de moyens détecteurs positionnés et orientés de manière à recevoir la lumière diffusée par réflexion sous des angles respectifs différents; et

déterminer la distance entre la surface de diffusion et la structure fixe en se basant sur la pluralité d'angles déterminés, en réduisant ainsi tout effet qu'exercent sur le faisceau lumineux diffusé par réflexion des motifs à réflectance variable se trouvant sur la surface de diffusion.

9. Procédé selon l'une quelconque des revendications 5 à 8, comprenant, en outre, les étapes consistant à :

diriger au moins une partie du faisceau lumineux (34) sur une première extrémité d'une masse de détection inertielle (406) se trouvant dans un moyen destiné à détecter l'accélération (400) du véhicule, ladite masse de détection inertielle (406) pouvant se déplacer d'une première position jusqu'à une seconde position en réponse à une force d'accélération appliquée, ladite première extrémité comprenant une matière (418) possédant un coefficient de réflexion connu;
mesurer un niveau d'intensité d'au moins une partie du faisceau lumineux (34) qui est diffusé par réflexion par la première extrémité de la masse de détection inertielle (406); et
détecter le déplacement de la masse de détection inertielle (406) depuis la première position jusqu'à la seconde position en se basant sur le niveau d'intensité mesuré de la lumière diffusée par réflexion par la première extrémité de la masse de détection inertielle.

10. Procédé d'actionnement d'un dispositif de retenue (38) pour sécurité comprenant les étapes du procédé de l'une quelconque des revendications 1 à 4 et comprenant en outre les étapes consistant à :

émettre un faisceau lumineux (34) vers une zone désignée située à l'intérieur du véhicule et occupée potentiellement par une personne;
mesurer un niveau d'intensité relatif ou une moyenne d'angles de diffusion d'au moins une partie du faisceau lumineux (34) qui est diffusé par réflexion par une surface située à l'intérieur de la zone désignée;
déterminer la distance entre la surface de diffusion et une structure fixe située à l'intérieur du véhicule en se basant sur le niveau d'intensité relatif ou sur la moyenne des angles de diffusion pour réaliser de ce fait ladite étape de détection continue;
déterminer une variation de la position statique de l'occupant sur une période de temps;
comparer la variation de ladite position statique de l'occupant sur une période de temps avec ladite valeur de seuil; et
actionner le dispositif de retenue pour sécurité si la variation de distance dépasse la valeur de seuil et si la variation de la position statique détectée de l'occupant n'est pas différenciée comme étant un mouvement non pertinent de l'occupant.

11. Système pour actionner un dispositif de retenue (38) pour la sécurité d'un occupant de véhicule en réponse à une collision de véhicule comprenant :

un moyen pour détecter, d'une façon continue, une position statique d'un occupant (24) de véhicule par rapport à une structure fixe située à l'intérieur du véhicule; et
un moyen de traitement comprenant :

un moyen pour discriminer une collision de véhicule nécessitant l'actionnement du dispositif de retenue (38) pour sécurité de l'oc-

cupant, ledit moyen de discrimination présentant une valeur de seuil de discrimination destinée à être utilisée dans l'analyse de discrimination; et un moyen réagissant aux données représentatives de la position statique détectée de l'occupant en ajustant la valeur de seuil de discrimination;
ledit système étant caractérisé en ce que ledit moyen de traitement comprend en outre un moyen servant à différencier les mouvements non pertinents de l'occupant du mouvement provoqué par une situation de collision et ledit moyen de différenciation différencie en se basant seulement sur la variation de ladite position statique détectée dans le temps.

12. Système selon la revendication 11, dans lequel ledit moyen de traitement comprend, en outre :

un moyen pour détecter une variation dans la position statique détectée de l'occupant;
un moyen pour déterminer la vitesse de l'occupant (24) en se basant sur la variation détectée de la position statique détectée de l'occupant;
un moyen pour comparer la vitesse de l'occupant avec la valeur de seuil de discrimination; et
un moyen pour actionner le dispositif de retenue (38) pour sécurité si la vitesse de l'occupant dépasse la valeur de seuil et si la variation de la position statique détectée de l'occupant n'est pas différenciée comme étant un mouvement non pertinent de l'occupant.

13. Système selon la revendication 11, comprenant en outre :

un moyen pour recevoir des données représentatives de l'accélération (400) du véhicule; et
ledit moyen de traitement comprenant, en outre, un moyen pour comparer les données représentatives de l'accélération du véhicule avec la valeur prédéterminée de seuil de discrimination, et un moyen pour actionner le dispositif de retenue (38) pour sécurité si les données représentatives de l'accélération du véhicule dépassent la valeur de seuil.

14. Système selon la revendication 11, comprenant en outre :

un moyen pour recevoir des données représentatives de l'accélération (400) du véhicule; et
ledit moyen de discrimination comprend en outre une valeur de seuil de discrimination d'accélération destinée à être utilisée dans l'analyse de discrimination et un moyen réagissant aux données représentatives de la position statique détectée de l'occupant en ajustant la valeur de seuil de discrimination d'accélération; et
ledit moyen de traitement comprenant en outre un moyen servant à comparer les données représentatives de l'accélération du véhicule avec la valeur de seuil de discrimination d'accélération, et un moyen servant à actionner le dispositif de retenue (38) pour sécurité si les données représentatives de l'accélération du véhicule dépassent la valeur de seuil d'accélération.

15. Système selon l'une quelconque des revendications 11 à 14, dans lequel ledit moyen de détection de position comprend :

un moyen pour émettre un faisceau lumineux (16) vers une zone désignée située à l'intérieur du véhicule et occupée potentiellement par une personne;
un moyen pour recevoir au moins une partie du faisceau lumineux (18) qui est diffusé par réflexion par une surface se trouvant à l'intérieur de la zone désignée;
un moyen pour mesurer le niveau d'intensité (102, 104, 206, 208, 210, 310) d'au moins une partie du faisceau lumineux reçu, ou angle sous lequel le faisceau lumineux est reçu; et
un moyen pour déterminer la distance entre la surface de diffusion et une structure fixe située à l'intérieur du véhicule en se basant sur le niveau d'intensité mesuré ou sur l'angle mesuré.

16. Système selon la revendication 15, comprenant en outre :

un moyen pour détecter l'accélération (400) du véhicule comportant une masse de détection inertielle (406) pouvant être déplacée depuis une première position jusqu'à une seconde position en réponse à une force d'accélération appliquée, ladite masse de détection inertielle (406) comportant une première extrémité comprenant une matière (418) à coefficient de réflexion connu;
un moyen pour diriger au moins une partie du faisceau lumineux émis (34) vers ladite première extrémité de ladite masse de détection inertielle (406);
un moyen pour mesurer un niveau d'intensité d'au moins une partie du faisceau lumineux qui est diffusé par réflexion par ladite première extrémité; et
un moyen pour détecter un déplacement de ladite masse de détection inertielle (406) depuis la première position jusqu'à la seconde position en se basant sur le niveau d'intensité mesuré

de la lumière diffusée par réflexion par ladite première extrémité.

17. Système selon l'une quelconque des revendications 11 à 13, dans lequel ledit moyen de détection de position comprend :

un moyen pour émettre un faisceau lumineux (34) vers une zone désignée située à l'intérieur du véhicule et occupée potentiellement par une personne;
un moyen pour recevoir au moins une partie du faisceau lumineux qui est diffusé par réflexion par une surface située à l'intérieur de la zone désignée;
un moyen pour détecter, en deux endroits différents séparés par une distance prédéterminée, le niveau d'intensité du faisceau lumineux reçu; et
un moyen pour déterminer la distance entre la surface de diffusion et la structure fixe en se basant sur un rapport entre les niveaux d'intensité détectés aux deux endroits différents.

18. Système selon l'une quelconque des revendications 11 à 13, dans lequel ledit moyen de détection de position comprend :

un moyen positionné à un premier endroit situé à l'intérieur du véhicule pour émettre un faisceau lumineux (34) vers une zone désignée située à l'intérieur du véhicule et occupée potentiellement par une personne (24);
un moyen détecteur positionné à un second endroit, les premier et second endroits étant séparés par une distance prédéterminée;
un moyen pour focaliser au moins une partie du faisceau lumineux qui est diffusé par réflexion de manière à former un point lumineux sur ledit moyen détecteur, ledit moyen détecteur fournissant un signal de sortie indicatif de l'endroit du point lumineux sur ledit moyen détecteur;
un moyen réagissant audit signal de sortie du moyen détecteur en déterminant l'angle sous lequel le faisceau lumineux diffusé par réflexion est reçu; et
un moyen pour déterminer la distance entre la surface de diffusion et la structure fixe en se basant sur l'angle déterminé.

19. Système selon l'une quelconque des revendications 11 à 13, dans lequel ledit moyen de détection de position comprend:

un moyen positionné à un premier endroit situé à l'intérieur du véhicule pour émettre un faisceau lumineux (34) vers une zone désignée située à l'intérieur du véhicule et occupée potentiellement par une personne (24);
une pluralité de moyens détecteurs positionnés chacun à des endroits différents, chaque endroit différent étant séparé du premier endroit d'une distance prédéterminée;
un moyen pour focaliser au moins une partie du faisceau lumineux qui est diffusé par réflexion de manière à former un point lumineux sur chacun des moyens détecteurs de ladite pluralité de moyens détecteurs, ladite pluralité de moyens détecteurs fournissant un signal de sortie indicatif de l'endroit du point lumineux respectif formé sur ces moyens détecteurs;
un moyen réagissant à ladite pluralité de signaux de sortie des moyens détecteurs en déterminant l'angle sous lequel le faisceau lumineux respectif diffusé par réflexion est reçu au niveau de chaque moyen détecteur de ladite pluralité de moyens détecteurs; et
un moyen pour déterminer la distance entre la surface de diffusion et la structure fixe en se basant sur la pluralité d'angles déterminés, en réduisant ainsi tout effet qu'exercent sur le faisceau lumineux (34) diffusé par réflexion des motifs à réflectance variable se trouvant sur la surface de diffusion.

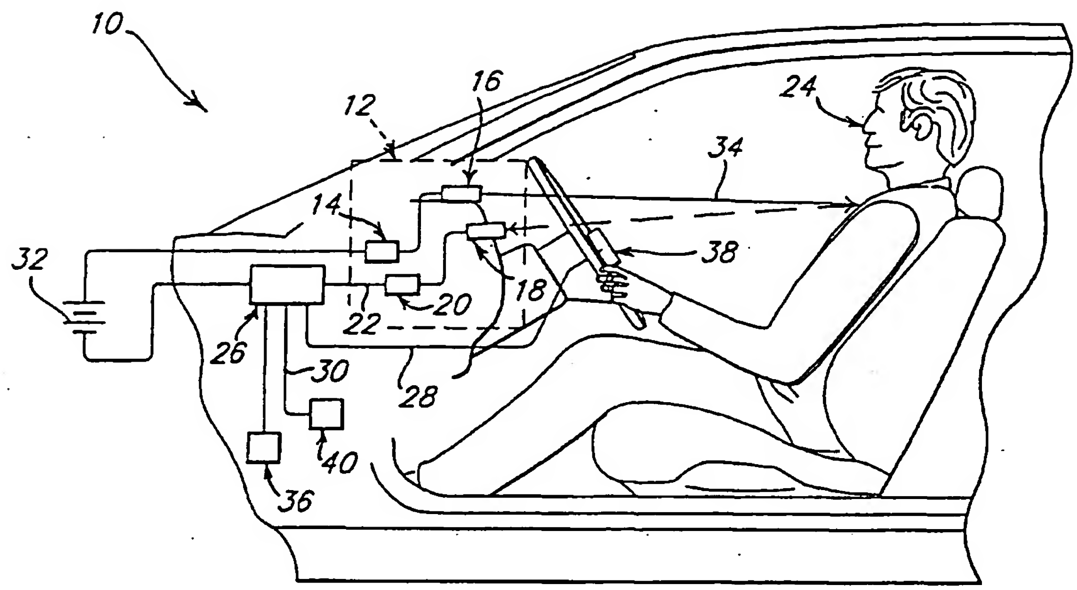


Fig. 1.

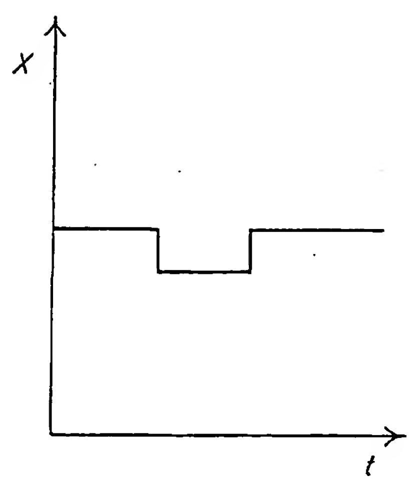


Fig. 5A.

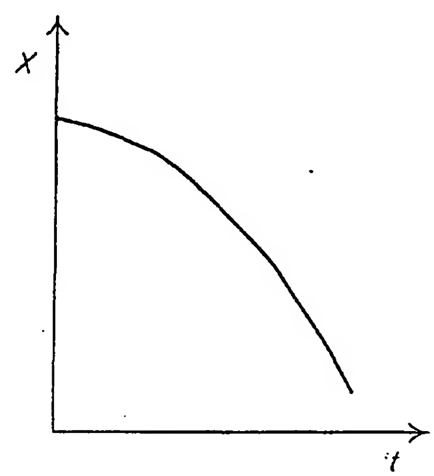
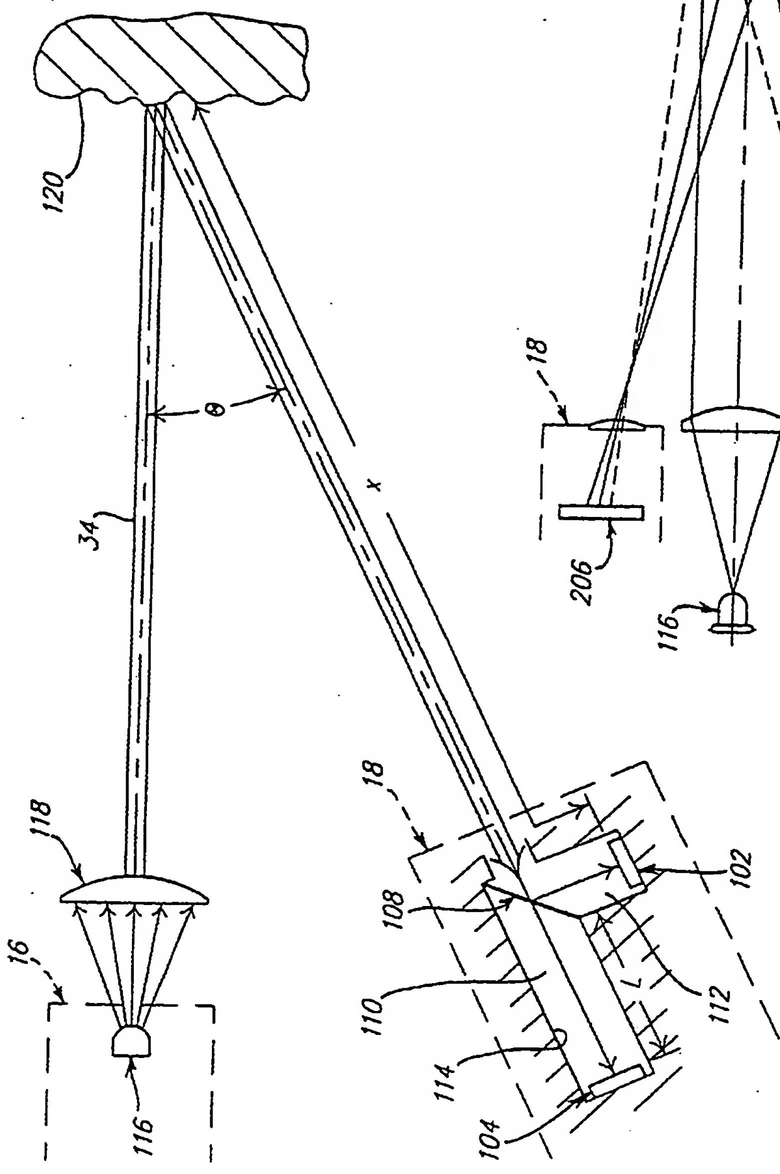


Fig. 5B.


100
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16
116
18
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114
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102
112
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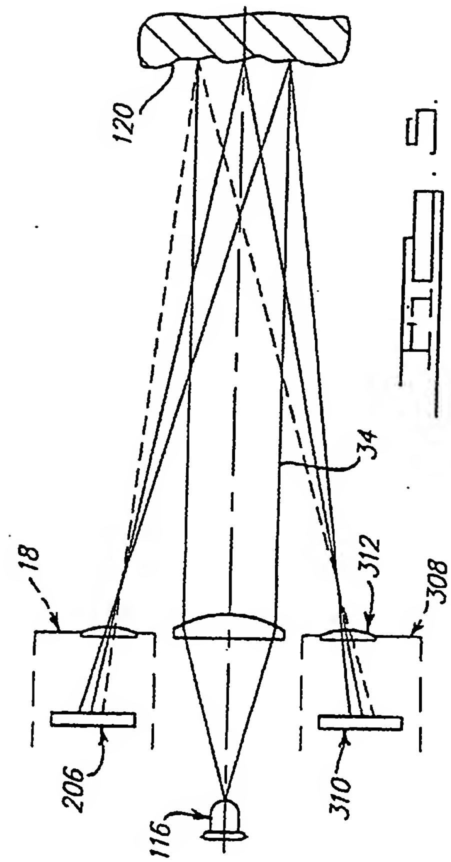
FIG. 2


120
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206
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310

FIG. 5

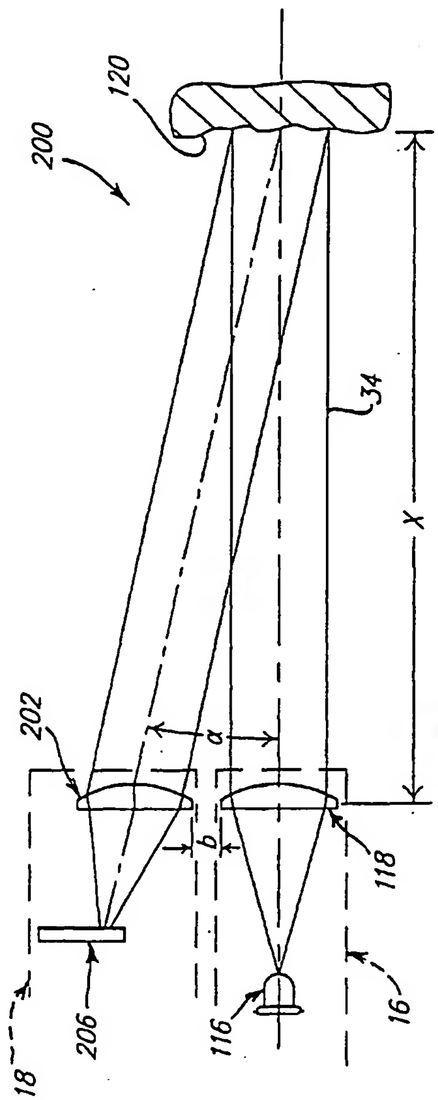

FIG. 3A.

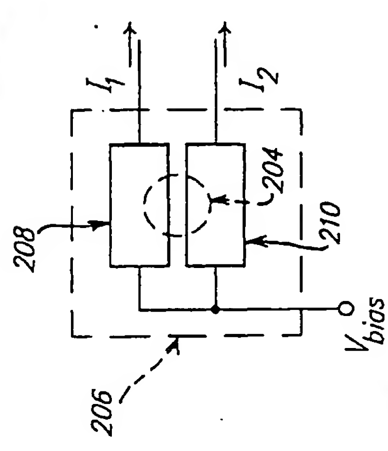

FIG. 3B.

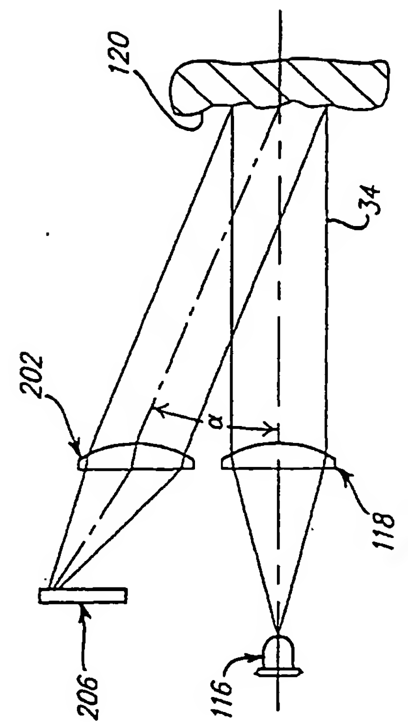

FIG. 3C.

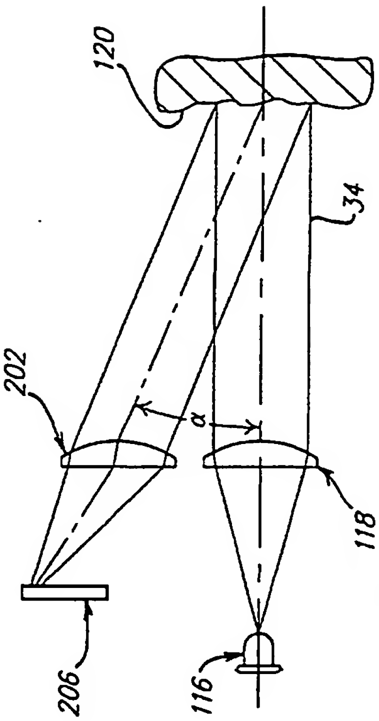

FIG. 4C.

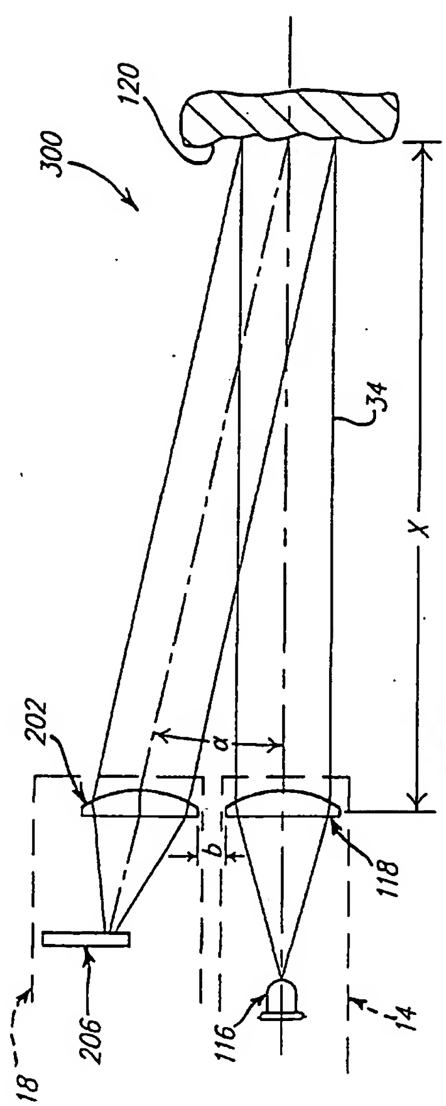

FIG. 4A.

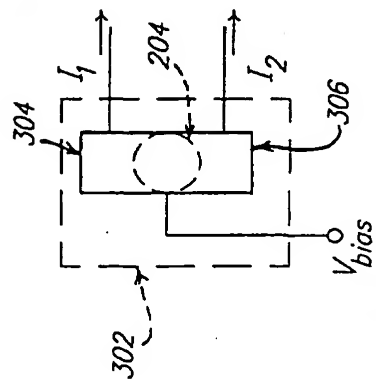

FIG. 4B.

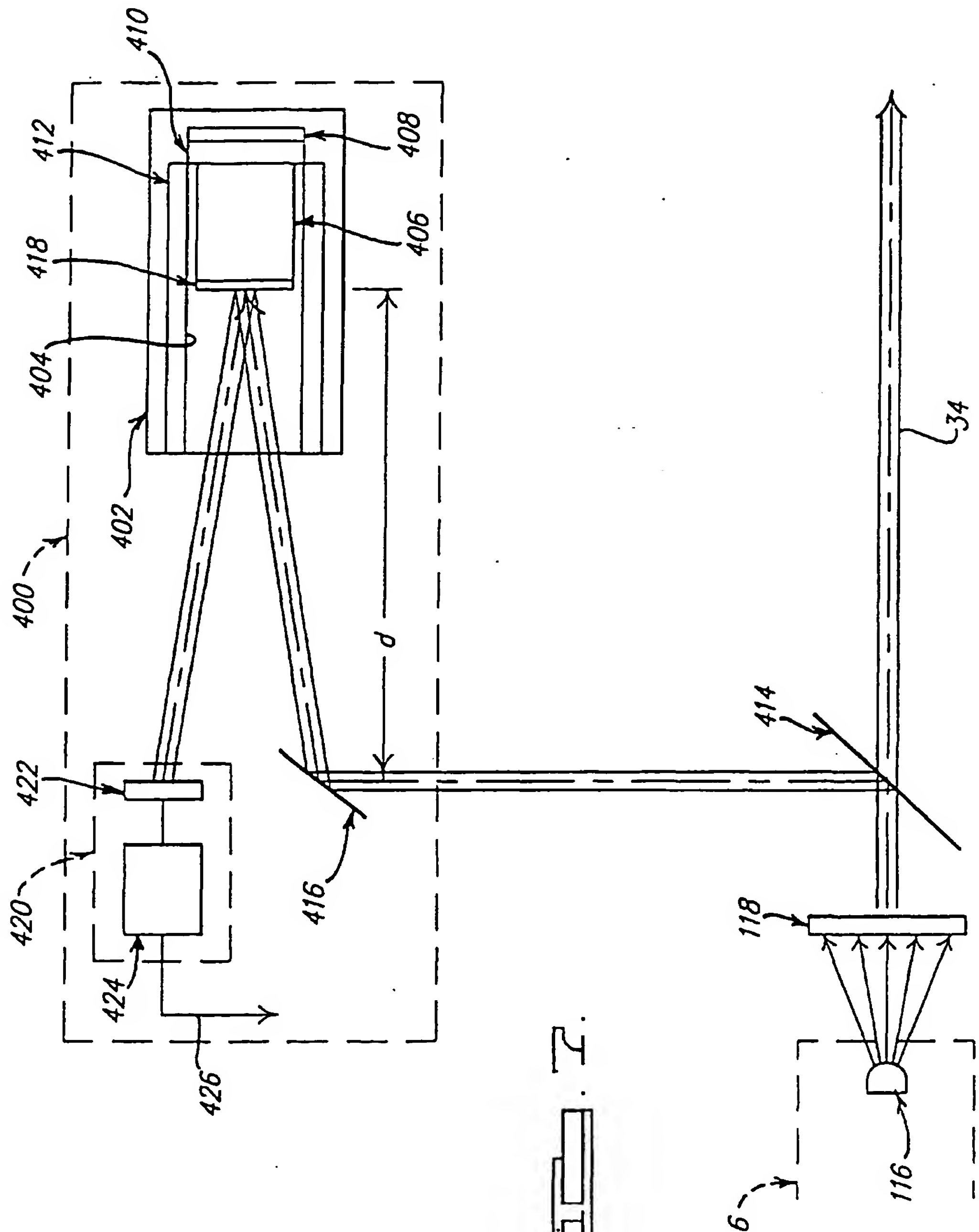
410
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FIG. 7